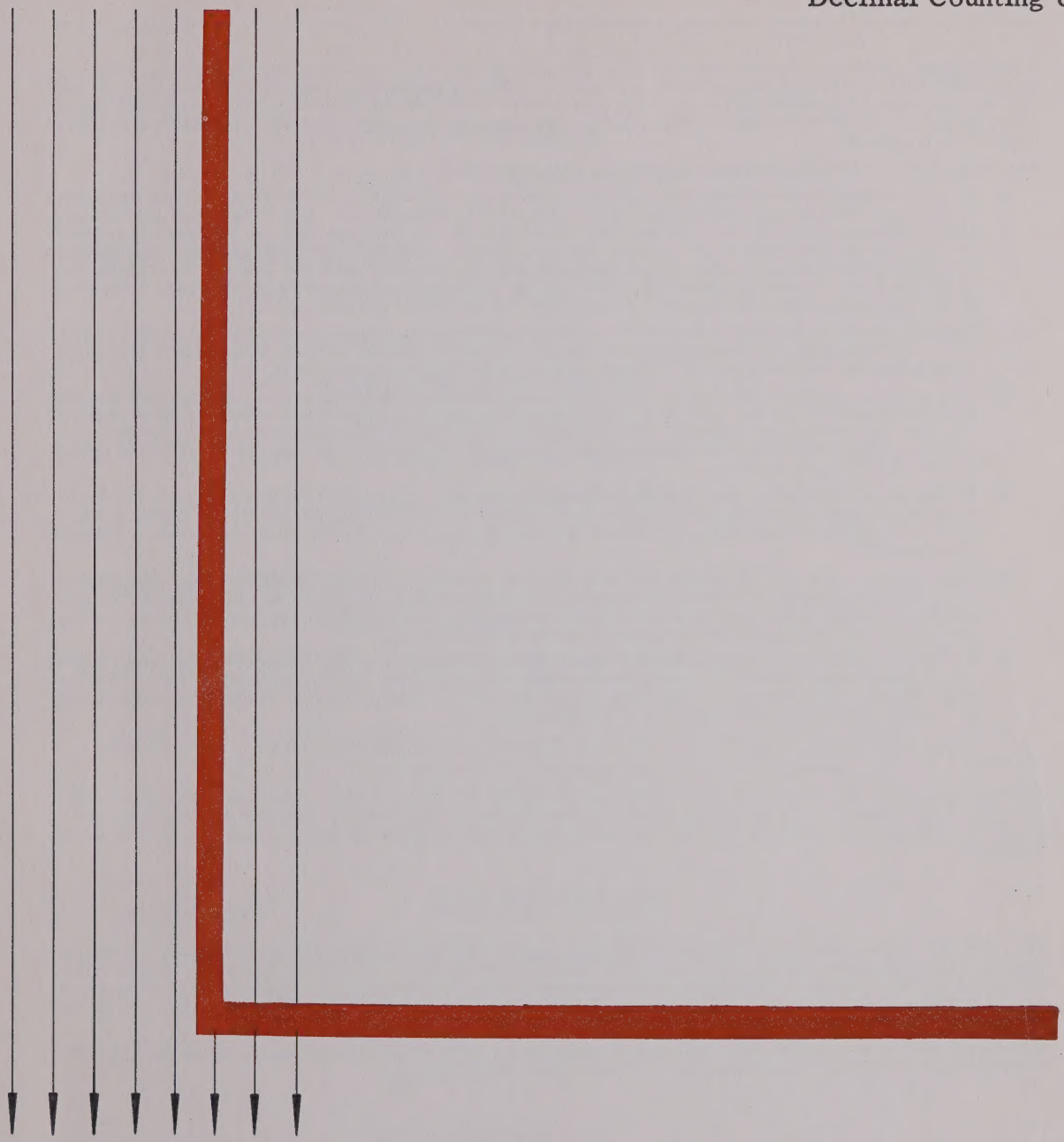
INSTRUCTION MANUAL

MODEL 850
Decimal Counting Unit



Beckman® INSTRUMENTS, INC.

BERKELEY DIVISION
2200 Wright Avenue
Richmond, California

December 1962

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
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SECTION 1

INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model 850 DCU is a plug-in electronic counting unit using solid state components mounted on a printed circuit board. The unit counts input pulses from zero to nine; each count is represented by output signals in binary (1-2-4-8) coded form. With an Electroluminescent Storage Unit this binary-coded output can be converted into a decimal digit display of the registered count.

At every tenth input pulse, the DCU generates an output signal suitable to drive another Model 850 DCU. Thus, any number of these units can be cascaded (the output of one connected to the input of the next) to form a counter whose total count capacity depends only on the number of DCU's.

Since each DCU generates one output pulse for every ten input pulses, these units can also be used as decade frequency dividers.

1.2 TECHNICAL CHARACTERISTICS

Count Indication

Binary-coded (1-2-4-8) electrical signals

Input Requirements

Voltage pulse, +10 to +25 volts amplitude*, 1μs minimum duration (0.5μs rise time).

Maximum Counting Rate

250,000 counts per second

Resolution of Paired Pulses

3 microseconds

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*The values given correspond to supply voltage levels listed under "Power Requirements". For values when other supply voltages are used, see Section 2.6.

Output Characteristics

Positive signal when count goes from "9" to "0", suitable for driving another Model 850 DCU.

Reset Requirement

Voltage pulse, -10 v amplitude*, 10μs minimum duration.

Power Requirements

22 ma at -15 v. (±5%)
2 ma at +10 v. (±5%)

(NOTE: The unit can operate at other voltage levels as well; see see Section 2.6).

Construction

Printed card plug-in unit (with 15-pin printed circuit connector).

Dimensions

1/2 inch wide, 3 11/16 inches high, 3 5/32 inches deep

Weight

1 1/2 oz.

*The values given correspond to supply voltage levels listed under "Power Requirements". For values when other supply voltages are used, see Section 2.6.

SECTION 2

OPERATION

2.1 MOUNTING THE UNIT

The DCU can be mounted by plugging into a 15 pin printed-card-connector. Typical connector: Ucinite 119510-MP-15C.

2.2 SUPPLYING POWER

Ordinarily, the unit operates with supply voltages of -15 volts and +10 volts, but other voltage levels can be substituted as indicated in Section 2.6. The negative voltage supply should be connected to pin K of the DCU connector, while the positive supply should be connected to pin J.

2.3 SUPPLYING INPUT SIGNALS

Connect the source of input signals to pin C of the DCU connector. The unit will register a count each time a pulse +10 to +25 volts in amplitude (with a minimum width of 1μs and a 0.5μs rise time) is applied to the input terminal.

Pin A (capacitor bypass) provides an alternate input. If used, this input should be driven through an external capacitor.

2.4 USING OUTPUT SIGNALS

The DCU supplies readout signals to terminals D, F, M, and P of the DCU connector. These signals are in two voltage states: -12 volts with respect to ground (pin S) for the binary "one", and -0.3 volts with respect to ground for the binary "zero". The binary states (each binary driving one readout line) represent the registered count in 1-2-4-8 binary code. Each readout line will supply a maximum steady state current of 2 ma into a load connected to B-. Table 1 indicates the state of the binaries for each registered count from 0 to 9.

Use Table 1 to convert a coded digit to a decimal digit. Note the weight of each column in which a "1" appears, then sum the weight. For example, the coded digit "1100" is equivalent to 1+2+0+0=3; and "0110" is equivalent to 0+2+4+0=6.

Table 1. State of the Binaries

DECIMAL DIGIT REGISTERED	FIRST BINARY STAGE (Weight 1)	SECOND BINARY STAGE (Weight 2)	THIRD BINARY STAGE (Weight 4)	FOURTH BINARY STAGE (Weight 8)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

The readout signals at terminals D, F, M and P drive an Electroluminescent Storage Unit for a visual indication of the registered count. In addition, the output signal produced at terminal R each time the count goes from 9 to 0 can be used to drive another Model 850 DCU or other circuitry.

2.5 RESETTING DCU TO ZERO

Reset lines H, L, and N are clamped at zero volts while the DCU counts. A negative pulse to lines H and L (line N clamped at zero volts) will reset the DCU to zero. The DCU can be set to 9 by applying a negative pulse to lines L and N (line H clamped at zero volts). A 10 microsecond, -10 volt pulse will reset the DCU. The reset pulse can be generated either electronically by transistor circuitry or mechanically through relay contacts.

2.6 SPECIAL OPERATING CONDITIONS

Although the operating characteristics described in previous sections are for power supply levels of -15 and +10 volts, the unit will function at other voltages as well. Proper combinations of B- and B+ voltages down to -8 and +4 volts respectively can successfully be used.

Those characteristics which are affected by the supply voltage levels will naturally vary with the value of the voltages used. Thus, for example, with a B- and B+ voltage of -8 and +4 volts, the amplitudes of the input, output, and reset signals will be approximately as follows (signal widths remain unchanged):

1) Input signal: +5 to +15 volts

2) Output signal: Potentials of 0 and -6 volts with respect to ground.

3) Reset signal: -10 volts

SECTION 3

CIRCUITS

3.1 THE BINARIES

The decimal counting unit consists of four binaries, each comprising a pair of p-n-p transistors connected in a scale-of-ten circuit. The transistor binaries are similar to vacuum tube binaries in that they have two stable states, and are alternately triggered from one state to the other by successive input pulses.

The major difference between the two types of binary is the operating characteristics of the transistors. In a transistor, the input impedance is low (in the order of a thousand ohms) when the base potential is negative. This low impedance allows a base current to flow and the transistor can conduct. On the other hand, a positive base potential results in a high input impedance (several hundred thousand ohms). Consequently, no base current flows and the transistor is cut off.

Assume, for example, that the first binary on the schematic diagram is initially in the "zero" state. In this state, Q2 is conducting while Q1 is cut off. A positive input voltage pulse applied through diode CR3 to the base of Q2 drives this transistor to cutoff. As a result, the base current that normally flows is diverted and Q2, therefore, stops conducting.

The same input pulse which is applied to CR3 cannot change the state of Q1 since this transistor is already cut off.

As the load current in Q2 decreases, the potential on its collector approaches B-. This change in voltage level, coupled through resistor R2 and capacitor C1 to the base of transistor Q1, drives Q1 into the active region. As a result, Q1 begins to conduct, and the amplified current flowing through R4 causes the potential on the collector to fall almost to zero. Under these conditions, the divider network consisting of R9 and R7 supplies a large enough positive potential to the base of Q2 to keep it cut off.

The binary, now in the "one" state, remains in this stable state until the next positive input pulse arrives. When this happens, Q1 is cut off, Q2 conducts, and the binary thus resumes its original state.

The collectors Q1, Q3, Q5, and Q7 are tied to terminals D, F, M, and P, respectively, of the DCU connector. A change in voltage level at each collector as the binary changes state is available as an output signal. In addition, one output of each binary is used as input to the following binary. Therefore, each binary in the DCU reverses state for every two reversals of the preceding binary.

3.2 THE SCALE-OF-TEN CIRCUIT

The scale-of-ten circuit used in the Model 850 DCU is actually a four-place binary counter wired so that it resets to zero on every tenth input pulse. Thus, for the first nine pulses, the binaries operate as in a conventional, 1-2-4-8 counter. At the count of eight, however, the negative potential on the collector of Q8 is fed back through R15 to the second binary. This places a bias on CR4 and CR5 so that the next positive pulse from Q2 will not trigger the second binary.

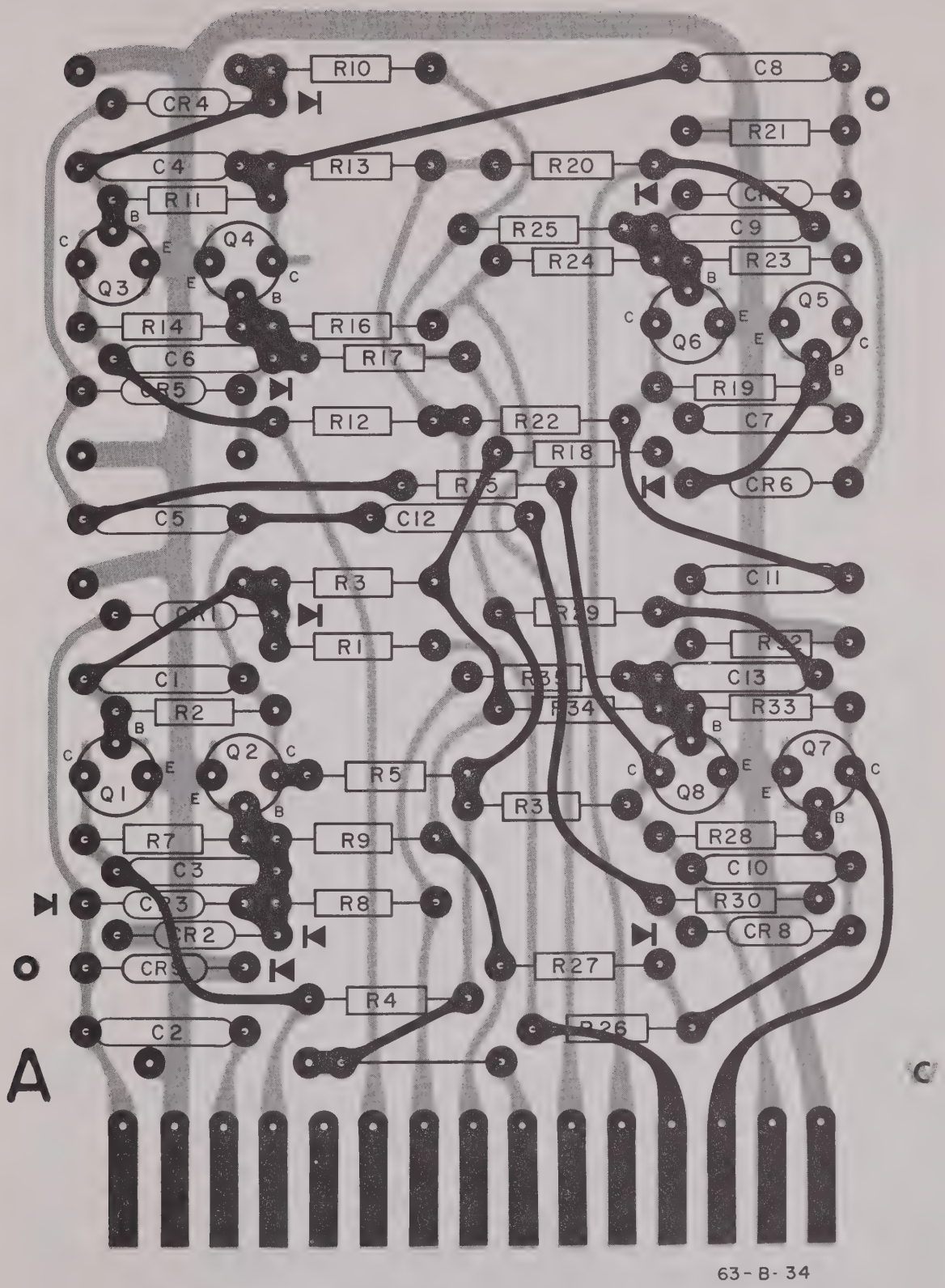
The tenth input pulse, then, flips the first binary to its "zero" state, but the corresponding positive transient at the collector of Q2 cannot trigger the second binary to the "one" state. However, this positive transient, coupled through C12 does trigger the fourth binary to its "zero" state.

At the tenth input pulse, therefore, all four binaries are in the "zero" state, the bias on CR2 and CR5 has been removed, and the circuit is ready for the next counting cycle.

The positive output signal from Q8, produced when the counter goes from nine to zero, can be used to drive another Model DCU. Thus, the DCU will supply one input pulse to the next DCU for every ten counts registered.

The number of counts registered by the DCU is represented in binary-coded form by the potentials on the binary readout lines. Only one output signal is available from each binary.

Reset lines H and L connect through a corresponding resistor to the base of the right-hand transistors (Q2, Q4, Q6, and Q8) of each binary. Reset line N connects to the base of the left-hand transistors (Q1 and Q7) of each binary. A negative voltage pulse applied to reset lines H and L (line N clamped at zero) will turn on all transistors on the right-hand side of each binary, setting the DCU to zero. A negative voltage pulse applied to reset lines L and N (line H clamped at zero) sets the DCU to nine.



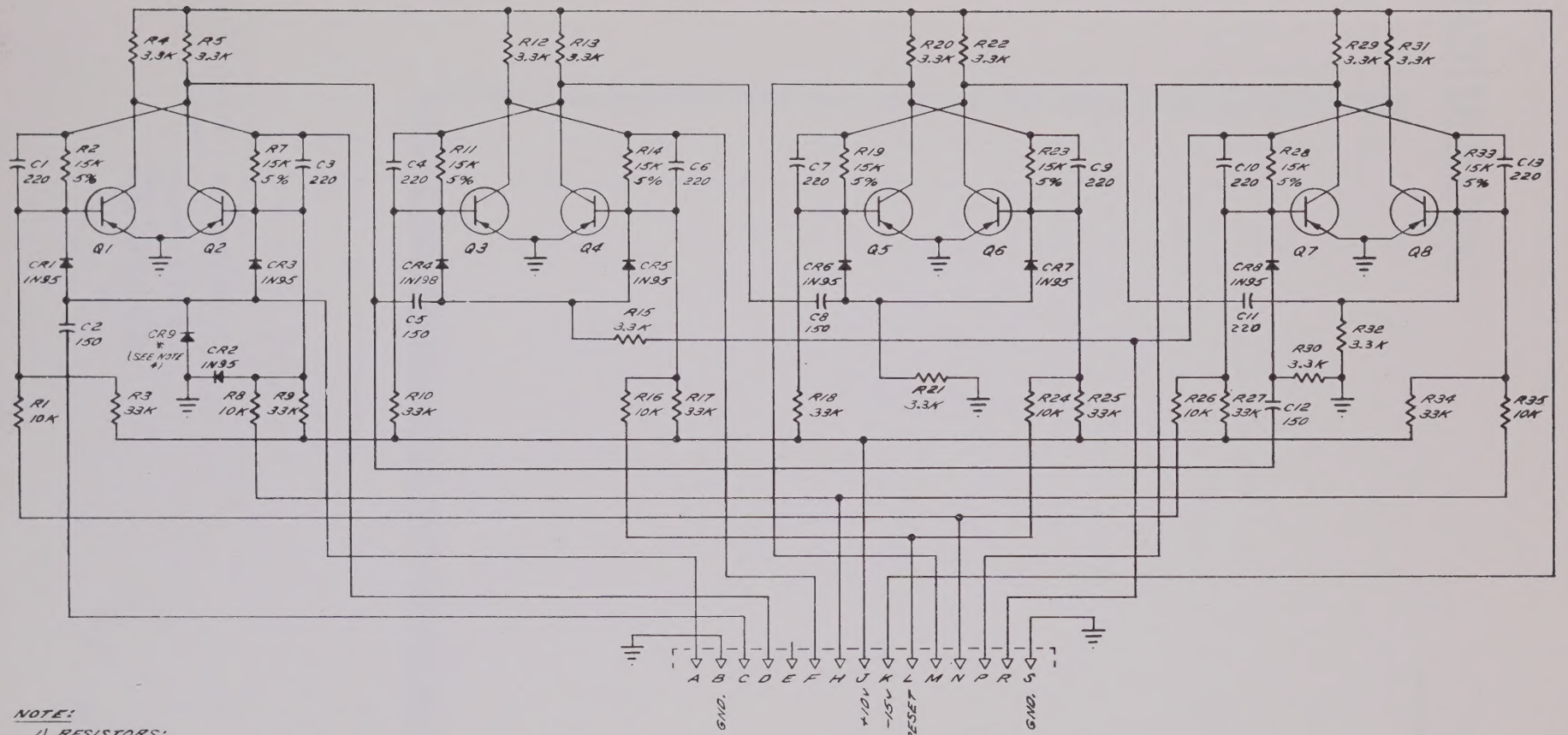
MODEL 850 DCU COMPONENT LAYOUT

SECTION 4

PARTS LIST

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
C1	637-824020	Capacitor, F. Mica, 220pf, 300V, 5%	9
C2	637-824018	Capacitor, F. Mica, 150pf, 300V, 5%	4
C3 & C4		Same as C1	
C5		Same as C2	
C6 & C7		Same as C1	
C8		Same as C2	
C9 thru C11		Same as C1	
C12		Same as C2	
C13		Same as C1	
CR1	755-402107	Diode, special	7
CR2 & CR3		Same as CR1	
CR4	755-800274	Diode, Germanium, 80 PIV, 4 ma, 1V min. fwd.	1
CR5 thru CR8		Same as CR1	
CR9	755-402107	Diode, special	1
Q1	755-800398	Transistor, Germanium, PNP, 150mw max.	8
Q2 thru Q8		Same as Q1	
R1	601-823108	Resistor, F. Comp., 10K, 1/4W, 10%	6
R2	601-822301	Resistor, F. Comp., 15K, 1/4W, 5%	8
R3	601-823109	Resistor, F. Comp., 33K, 1/4W, 10%	8
R4	601-823942	Resistor, F. Comp., 3.3K, 1/4W, 10%	12
R5		Same as R4	

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
R7		Same as R2	
R8		Same as R1	
R9 & R10		Same as R3	
R11		Same as R2	
R12 & R13		Same as R4	
R14		Same as R2	
R15		Same as R4	
R16		Same as R1	
R17 & R18		Same as R3	
R19		Same as R2	
R20 thru R22		Same as R4	
R23		Same as R2	
R24		Same as R1	
R25		Same as R3	
R26		Same as R1	
R27		Same as R3	
R28		Same as R2	
R29 thru R32		Same as R4	
R33		Same as R2	
R34		Same as R3	
R35		Same as R1	
	864-412958	Pad, converter transistor	8



NOTE:

1) RESISTORS:
   WATTAGE ——— 1/2 W., UNLESS NOTED.
   TOLERANCE ——— 10%, " "
2) CAPACITORS:
   CAPACITY ——— IN Pf, " "
   VOLTAGE ——— 300v, " "
   TOLERANCE ——— 5%, " "
3) TRANSISTORS ARE — 2N404.

DIODE IS BECKMAN SPEC. 755-402107.

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